Mikropočítačové Systémy

MIPS

Distribuované vnorené počítačové systémy

Distributed Embedded Computer System

(Microcontrollers)

Prednáška 10.
RTC.

Niektoré mesiace v roku majú 31 dní a niektoré 30 dní.
Koľko mesiacov v roku má 28 dní?

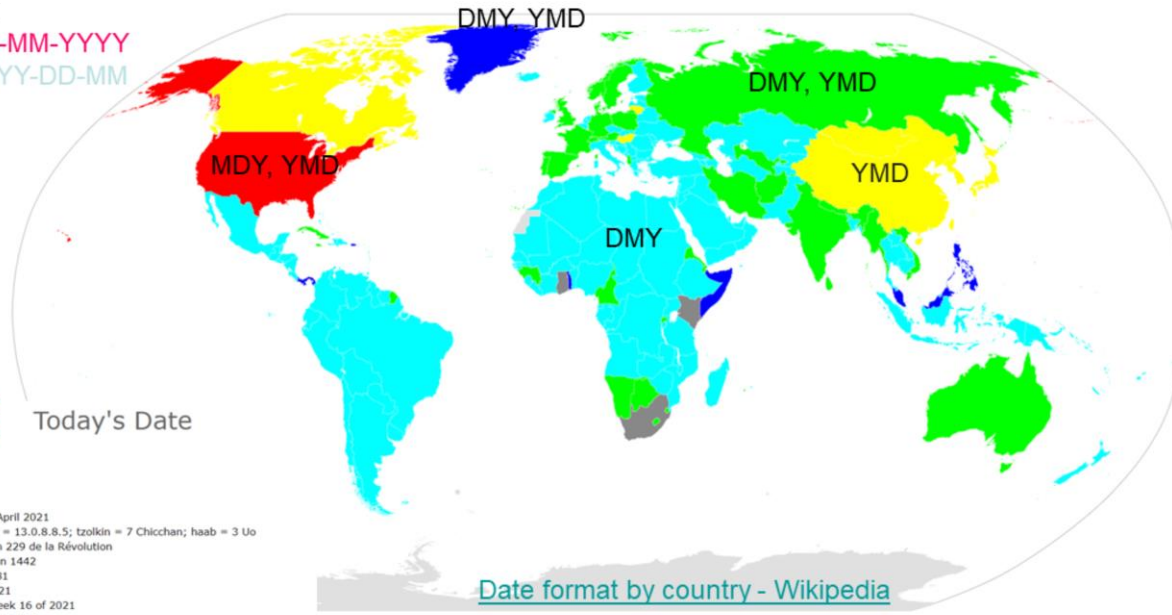
Systém reálneho času: Správny výsledok v správnom čase.

Test:

- Archeológovia našli mincu s datovaním 128 B.C. Je minca pravá?
- Začiatok 3 tisícročia bol:
  - 1. Jan. 2000
  - 1. Jan. 2001
  - Iný dátum.
- Koľko sekúnd má jedna minúta?
  - 60 sekúnd . (číslice 0, 1, 2, … 58, 59)
  - 60 sekúnd. (číslice 1, 2, … 58, 59, 60)
  - Prevážne 60 s. Niektorá môže mať len 59 sekúnd (číslice 0, 1, 2, … 58), iná až 61 sekúnd (číslice 0, 1, 2, … 58, 59, 60).

2

Absolútny čas:
SS.MM.HH DD-MM-YYYY
SS.MM.HH YYYY-DD-MM



Date format by country - Wikipedia

isotropic.org Today's Date

If this is working, then

Today is:

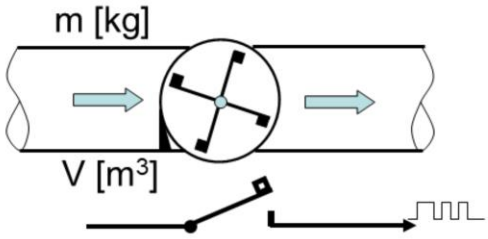
Gregorian: Friday, 23 April 2021
Mayan: Long count = 13.0.8.8.5; tzolkin = 7 Chicchan; haab = 3 Uo
French: 4 Floréal an 229 de la Révolution
Islamic: 11 Ramadan 1442
Hebrew: 11 Iyar 5781
Julian: 10 April 2021
ISO: Day 5 of week 16 of 2021
Persian: 3 Ordibehest 1400
Ethiopic: 15 Miyazya 2013
Coptic: 15 Barmundah 1737
Chinese: Cycle 78, year 38 (Xin-Chou), month 3 (Ren-Chen), day 12 (Xin-Chou)
Julian day: 2459328
Day of year: Day 113 of 2021; 252 days remaining in the year
Discordian: Pungenday, Discord 40, Year of Our Lady of Discord 3187

Enter a (Gregorian) date: Convert this date

3

Relatívny čas: Príklady z praxe

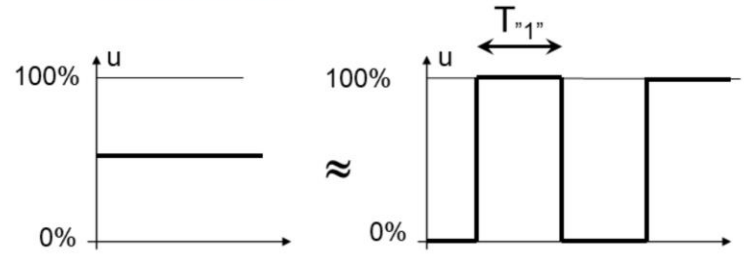
Meranie prietoku:



Počet impulzov ⇒ počítadlo

„Jednotka času“ ⇒ počítadlo, do ktorého vstupuje presná frekvencia

A/D a D/A prevodníky ⇒ PWM



$$\text{Plnenie} = \frac{T_{"1"}}{T_{op}}$$

WDT: Kontrola behu programu. Voľne povedané program (task) by sa mal pravidelne niekde objaviť a zamávať nám: „Tu som“.
Realizácia: „beží hardwarový časovač“, generuje pílu, po dopočítaní sa prednastaví a vygeneruje signál RST.
Periódu prednastavovania povie technológ.
„Program“ musí pred pretečením prednastaviť počítadlo pomocou ATOMICKEJ OPERÁCIE.

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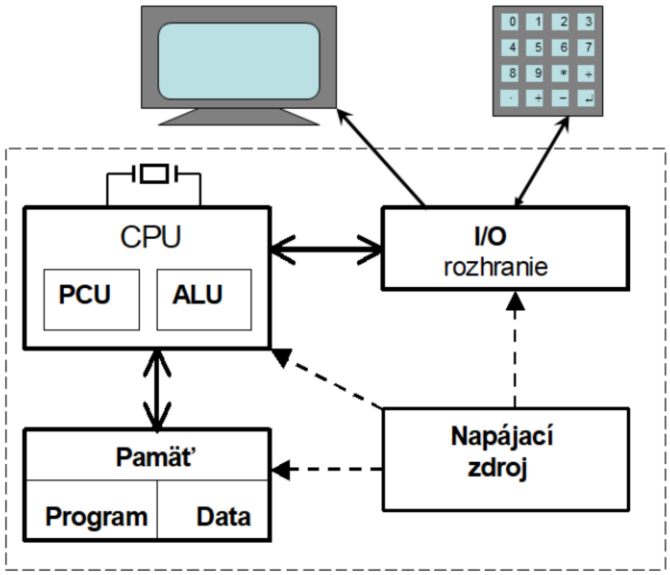
História počítačov:
Von Neumanov počítač



Zlepšenie vlastností von Neumanovho počítača

Sériový stroj, ak ho chceme urýchliť treba:

- Zvýšiť f_{CPU} ⇒ dve zbernice
- Zreťaziť inštrukcie, operácie ⇒ zmena myslenia
- Delegovať právomoci ⇒ vytvorenie periférií:
  - Display (DMA - „8257“ + riadenie zobrazenia - „8275“)
  - Klávesnica „8278“
  - čítače/časovače (základ RTC) „8253“
  - Binárne vstupy a výstupy „8255“
  - USART „8251“
  - Prerušovací podsystém, „8259“
  - I2C, A/D a D/A prevodníky, ...

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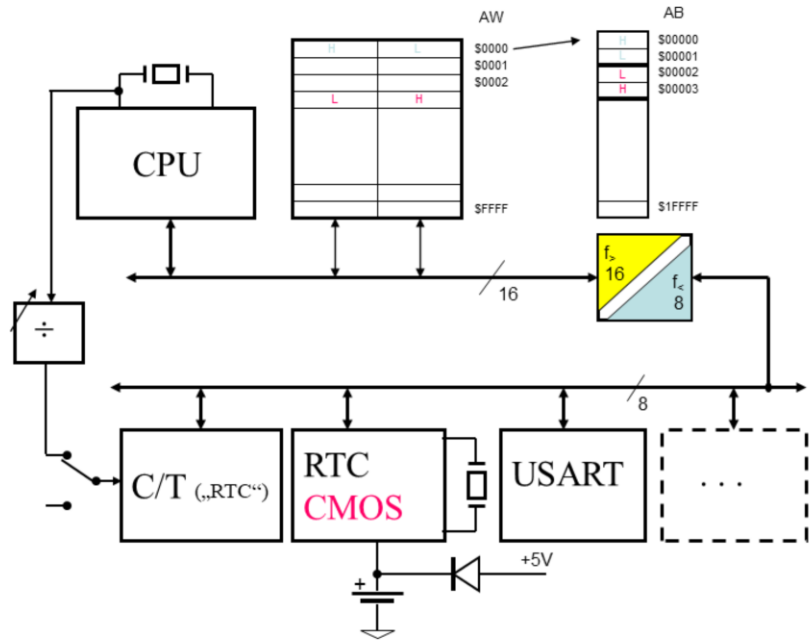
V čom je rozdiel medzi počítačom RT a NRT?
Má RTC?
Má WDT?
Má C/T? Má OS?
Má A/D a D/A (PWM) prevodníky?
…

Systém reálneho času je:
Hardware & Software.
Dáva správny výsledok v správnom čase.



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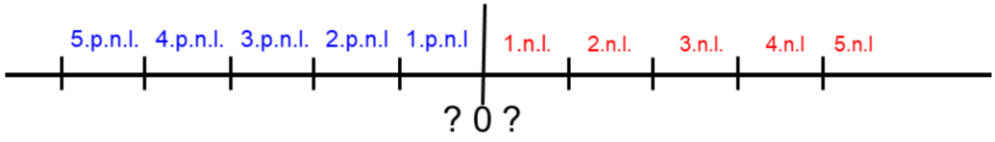
Y2K – problém pri prechode

31.12.1999 na 1.1.2000, správnejšie 31.12.2000 na 1.1.2001.

Otázka: Rok 2000 patrí do 20., resp. 21. str.?

Odpoveď: Počiatok nášho letopočtu zaviedli

v „3-ťom storočí“ a stanovili počiatok: narodenie Ježiša Krista. Časová os vyzerala asi takto:



História „0“

„Nulu“ ako číslicu začali používať v Indii okolo roku 600.

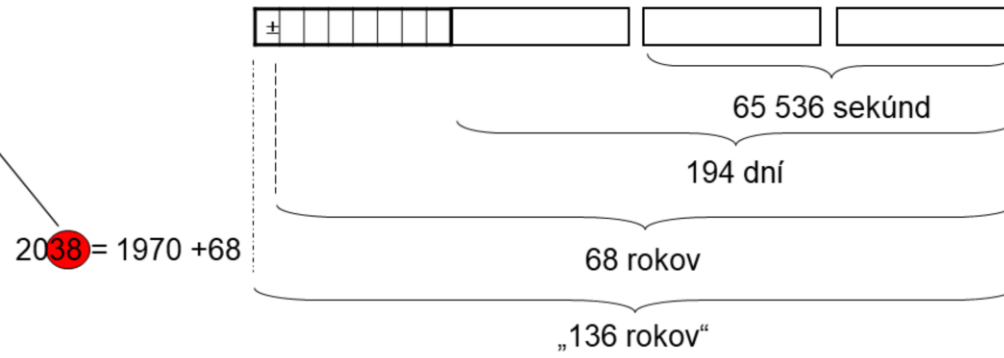
Európa používala do roku 1400 rímske číslice. Fibonači „doniesol“ do Európy arabské číslice a NULU. Začína sa používať polyadická (pozičná) číselná sústava.

⇒ 1.storočie 1 až 100, 2. storočie 101 až 200, atď.
Tisícročia: 1 až 1000, 1001 až 2000, 2001 až 3000

7

Y2K38

- „Unixový“ čas sa zaznamenáva ako počet sekúnd od polnoci na 1.jan. 1970
- Pôvodne sa ukladal ako integer (32b) $\Rightarrow 2^{31} - 1 = 2\ 147\ 483\ 647$ sekúnd
- Jeden deň = 86400 sekúnd



2038 = 1970 +68

Tento problém sa už začína prejavovať pri hypotékach.
Prakticky sa zrejme neprejaví, pretože sa už dnes používajú 64-bitové počítače.

8

Priestupný rok

Rok, v ktorom je jeden deň naviac.
Dôvod: Synchronizácia s astronomickým rokom, ktorého dĺžka je cca 365,25 dňa.

Skutočnosť je trocha „kratšia“. Preto nie každý štvrtý rok je priestupný.

Zo storočí sú priestupné len tie, ktoré sú súčasne bezo zvyšku deliteľné 100-ou a 400-ou.

Napr.: obvod PCF8563 bude považovať rok 2100 za priestupný, aj keď nie je.

Obvod PCF8583 počíta roky modulo štyri, to znamená treba ošetriť priestupné roky softwarovo.

PCF8563 & PCA8565: 8-bit register rokov v BCD formate.

Na určenie storočia je vyhradení jednobitový príznak. Tento príznak sa zmení, ak rok „pretečie“. 99 → 00.

PCF8583 & PCF8593: tieto obvody majú štvorročný kalendár.

Atď.

9

Juliánsky kalendár bol modifikovaný v roku 1582 páp. Gregorom XIII.
Z októbra odstránil 10 dní.
Po štvrtku 4.X.1582 nasledoval piatok 15.X.1582.
Zaviedol:

- komplikovaný výpočet dátumu na ktorý pripadne Veľká Noc,
- priestupný rok.

Február bude mať 29 dní, ak rok je bezo zvyšku deliteľný štyrmi.
Zo storočí sú priestupné len tie, ktoré sú deliteľné číslom štyristo.

```
IF (Y mod 4 < > 0) {Február =28 }
ELSE { IF (Y mod 400 = 0 ) { Február = 29 }
        ELSE { IF (Y mod 100 = 0 ) { Február =28 }
                ELSE { Február =29 }
              }
     }
```

Problémom je: tropický rok má 365,2422 dní, Nie je to celé číslo.
Dá sa vyjadriť približne:

$$365 + 1/4 - 1/100 + 1/400 - 1/4000 \text{ [deň]}.$$

Chyba o jeden deň každých rokov:

10

Číslovanie týždňov:

Za prvý týždeň v roku je považovaný ten, do ktorého padne prvý štvrtok nového roku.

Rok / Deň	2018		2019		**2020**		2021	
Po	1.Jan.	8.		7.		6.		4.
Ut	2.	9.	1.Jan.	8.		7.		5.
St	3.	10.	2.	9.	1.Jan.	8.		6.
Št	4.	11.	3.	10.	2.	9.		7.
Pi	5.	12.	4.	11.	3.	10.	1.Jan.	8.
So	6.	13.	5.	12.	4.	11.	2.	9.
Ne	7.	14.	6.	13.	5.	12.	3.	10.
	1.týždeň		1.týždeň		1.týždeň			1.týždeň

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Deň v týždni:

Nedeľa	Pondelok	Utorok	Streda	Štvrtok	Piatok	Sobota
0	1	2	3	4	5	6

Výpočet dňa v týždni:

$\text{int}(x) = \lfloor x \rfloor$

$$w = (D + \lfloor 2.6m - 0.2 \rfloor + y + \lfloor \tfrac{1}{4} y \rfloor + \lfloor \tfrac{1}{4} c \rfloor - 2c) (\text{mod } 7),$$

$$m = \begin{cases} M-2 & ak \quad M \geq 3 \\ M+10 & ak \quad M \leq 2 \end{cases} \qquad Y^* = \begin{cases} Y & ak \quad M \geq 3 \\ Y-1 & ak \quad M \leq 2 \end{cases}$$

$y = Y^* (\text{mod } 100)$ Roky $\qquad c = \lfloor Y^* / 100 \rfloor$ Storočie

	Ne	Po	Ut	St	Št	Pi	So	Ne	Po	Ut	St	Št	Pi	So	Ne	
-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8

Dnes: 26.04.2021 D.M.Y

$D = 26, \quad m = 2, y = 21, c = 20$

$\lfloor 2{,}6m - 0{,}2 \rfloor = 5$

$\left\lfloor \frac{1}{4} y \right\rfloor = 5$

$\left\lfloor \frac{1}{4} c \right\rfloor = 5$

$x = (26 + 5 + 21 + 5 + 5 - 40)$

$w = x(mod\ 7) = 22(mod\ 7) = 1$

$\Longrightarrow$ *Pondelok*

12

GMT, UTC – priestupné sekundy

- GMT (Greenwich Mean Time) je odvodený od „pohybu“ slnka vzhľadom na nultý poludník. Pohyb je v rôznych ročných obdobiach „nerovnomerný“
- Astronómovia zaviedli UT (Universal Time). UT0 = GMT. Atď. Na presnosť vplýva: pohyb pólov, príliv - odliv, pohyby vo vnútri zeme, ...
- Zaviedol sa Atómový čas. Jednotkou je Atómová sekunda. Referenčný deň je tvorený 86400 As.
- Synchronizácia Atómového času a rotácie zeme sa označuje UTC. Pridávajú sa priestupné sekundy tak, aby chyba medzi nimi bola menšia ako 0,9 sek.

RTC

Základom je oscilátor f_{osc} = 32768 Hz =
= 256 * 128 = $2^8 * 2^7$

⇒ Základný krok je 1/64 sek.

Ale sekundy delíme na 1/10 s, 1/100 s.

Vyrába sa niekoľko podobných obvodov HRČ - RTC.

Rozdelenie podľa spôsobu pripojenia:

- Paralelnú dátovú zbernicu 8b, resp.4b
- Sériovú zbernicu

Comparison of six real time clocks

Features	PCx85x3 family				PCx212x family	
	PCF8563	PCA8565	PCF8583	PCF8593	PCF2123	PCA2125
Unique features	Very low power consumption	AEC-Q100 automotive qualification	High resolution, RAM, event counter	High resolution, event counter	Extremely low power consumption, electronic tuning	AEC-Q100 automotive qualification
Type of interface	I^2C	I^2C	I^2C	I^2C	SPI	SPI
Interface bus speed	400 kHz	400 kHz	100 kHz	100 kHz	7 MHz	7 MHz
Scratch pad RAM	no	no	240 bytes	no	no	no
Year / leap year tracking	yes / yes	yes / yes	yes / yes	yes / yes	yes / yes	yes / yes
Year counter	2 digit + 1 century bit	2 digit + 1 century bit	2 bit (4 years)	2 bit (4 years)	2 digit (99 years)	2 digit (99 years)
100 ms, 10 ms time register	no	no	yes	yes	no	no
Electronic tuning register	no	no	no	no	yes	no
Programmable alarm and timer functions	yes	yes	yes	yes	yes	yes
Low voltage detector	yes	yes	no	no	yes	no
Event counter mode	no	no	yes	yes	no	no
Option to select between two I^2C addresses	no	no	yes	no	no	no
Integrated oscillator capacitor	1 at OSCO	1 at OSCO	1 at OSCO	1 at OSCO	2	1 at OSCO
Supply voltage range	1.8 V – 5.5 V	1.8 V – 5.5 V	2.5 V – 6.0 V	2.5 V – 6.0 V	1.6 V – 5.5 V	1.6 V – 5.5 V
Clock operating voltage	1.0 V – 5.5 V	1.8 V – 5.5 V	1.0 V – 6.0 V	1.0 V – 6.0 V	1.1 V – 5.5 V	1.3 V – 5.5 V
Typical current consumption	250 nA at V_{DD} = 1 V	650 nA at V_{DD} = 3 V	2 µA at V_{DD} = 1 V	1 µA at V_{DD} = 2 V	100 nA at V_{DD} = 2 V	550 nA at V_{DD} = 3 V

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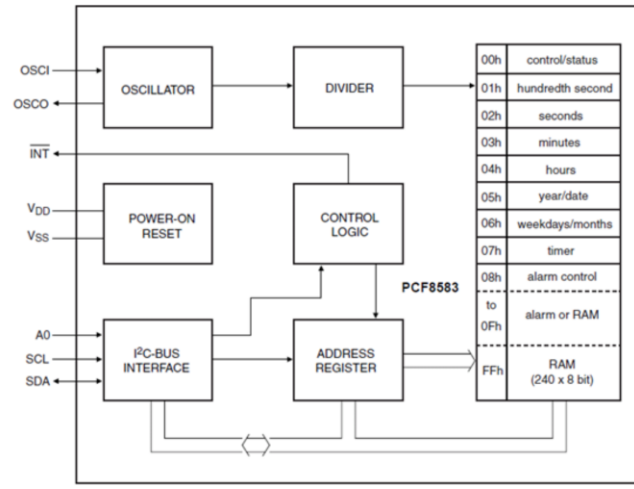
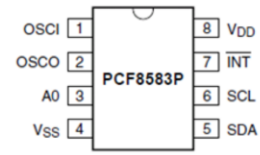
PCF 8583 – RTC

Vlastnosti:
- Základ tvorí CMOS RAM 256 B (2048b)
- I2C; možnosť pripojenia dvoch obvodov (pin A0)
  slave adresa (0x50, 0x51) pre: RD A1h alebo A3h
  WR A0h alebo A2h
- zabudovaný AC sa inkrementuje automaticky po každom RD resp. WR.
- zabudovaný 32768Hz osc.,
- Pamäť: + 8B (hodiny, kalendár) + 8B (alarm) + 240 voľná RAM
- platnosť dát (1,0V až 6,0V)
- Zabudovaný Power-on Reset.

Počíta 1/100 sek. až roky modulo 4.
Aby boli vstupom 1/100 sek,
f_{osc} je prenásobené číslom 100/128.



Block diagram of PCF8583



Pin configuration for DIP8 (PCF8583P)

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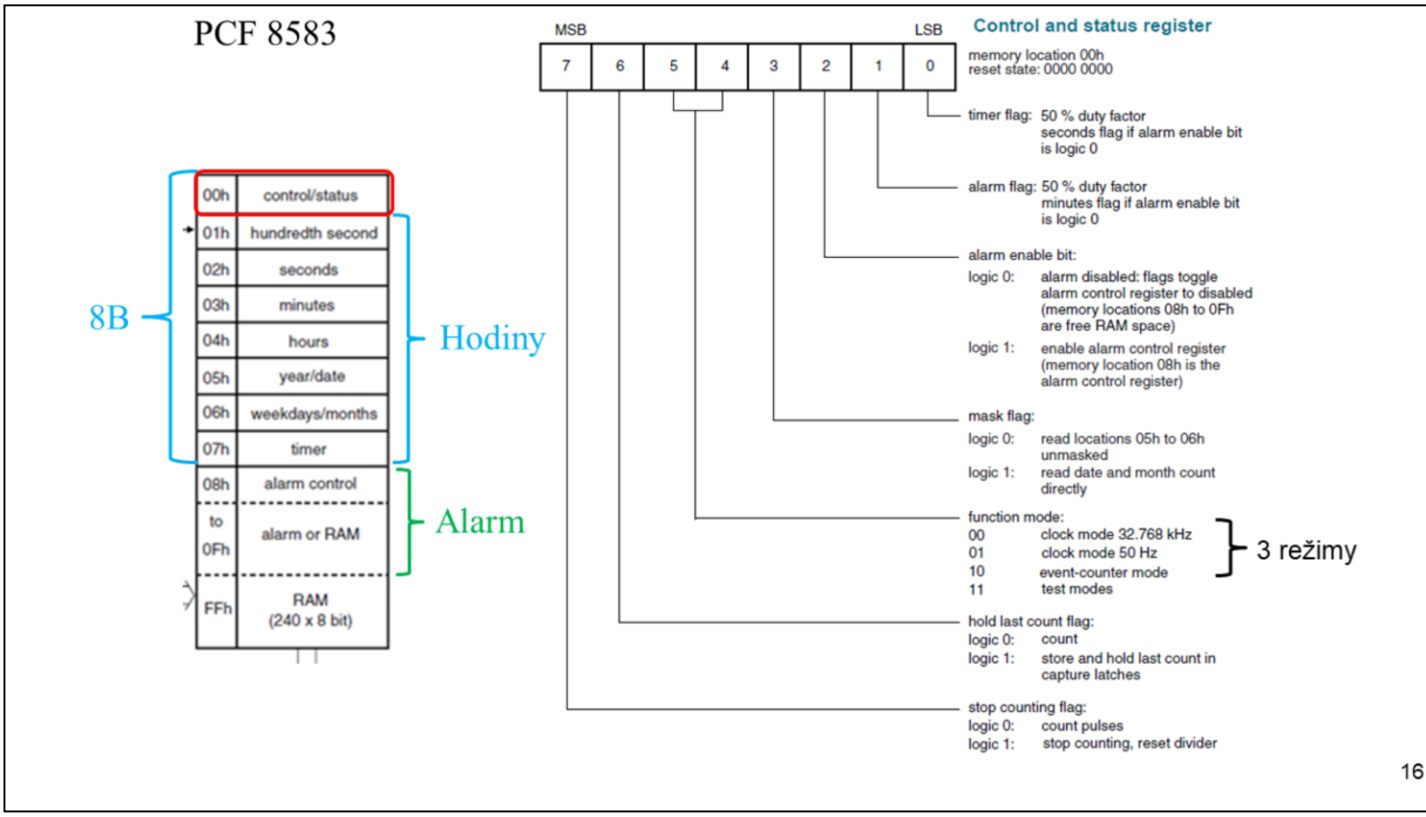


V mode hodiny načátava.

PCF 8583

Ak je zvolený mód Hodiny, potom

hundredths of a second, seconds,
minutes, hours,
date, month(four year calendar) a weekday

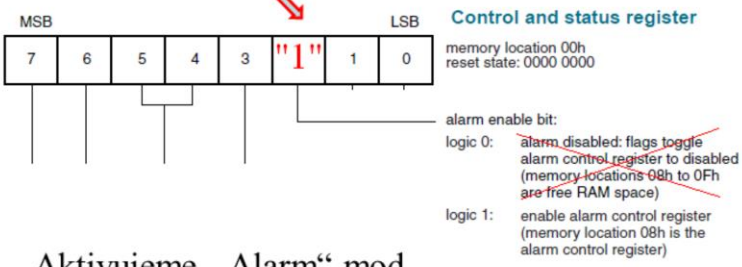
sú ukladané v Binary Coded Decimal (BCD) formate.

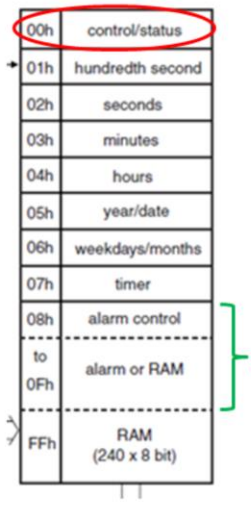
Ak je jeden z čítačov (01h až 07h) RD
obsah ostatných sa odpamätá (na začiatku RD operácie) do záchytných registrov. Zabráni sa tým chybám pri ikremente cez rády.

WR operácia sa týka len jedného čítača.

PCF 8583

Ak nastavíme





Aktivujeme „Alarm“ mod

Typy alarmov:
- „čas“ v rámci dňa
- „čas“ v rámci dňa + deň v mesiaci
- „čas“ v rámci dňa + deň v týždni

Signalizácia alarmov:
- nastaví sa príznak v „Control and Status reg.“
- plus požiadavka o prerušenie (otvorený kolektor)

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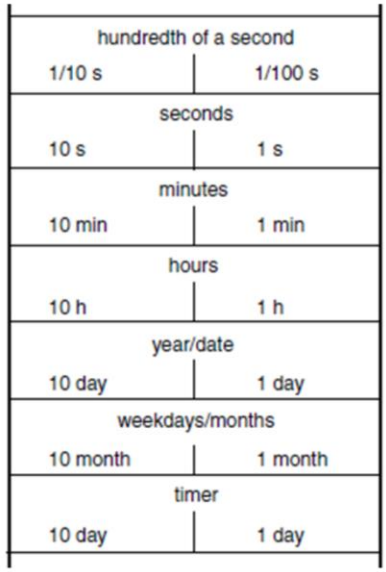
PCF 8583

Počítadlá času + dátum:



01h	0 až 99
02h	0 až 59
03h	0 až 59
04h	
05h	
06h	
07h	

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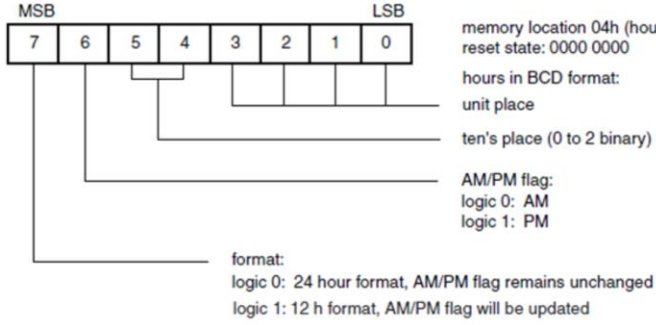
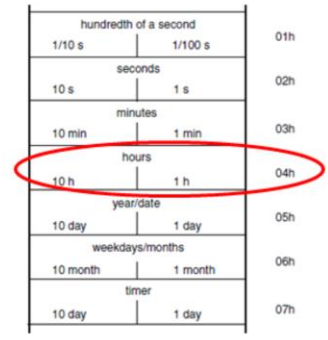
PCF 8583

Počítadlá času + dátum:

Format of the hours counter





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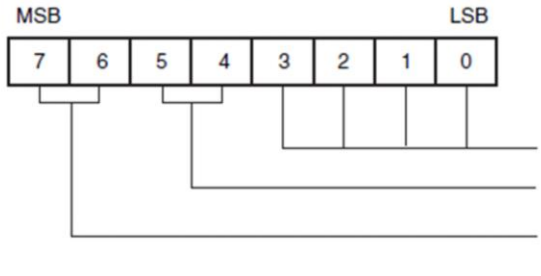
PCF 8583

Format of the year and date counter



memory location 05h (year/date)
reset state: 0000 0001

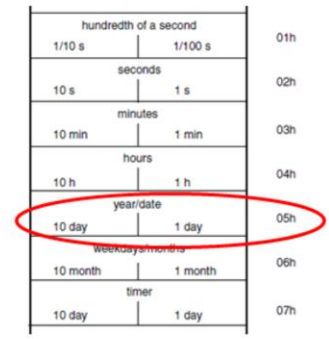
days in BCD format:

unit place

ten's place (0 to 3 binary)

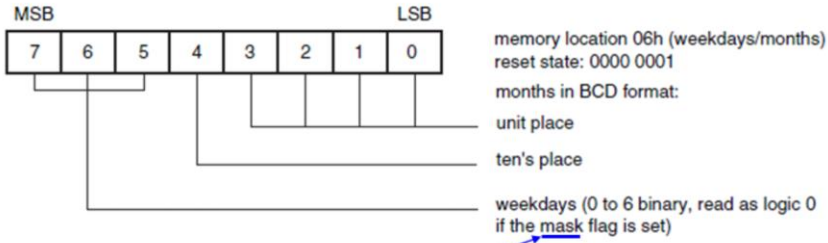
year (0 to 3 binary, read as logic 0
if the mask flag is set)

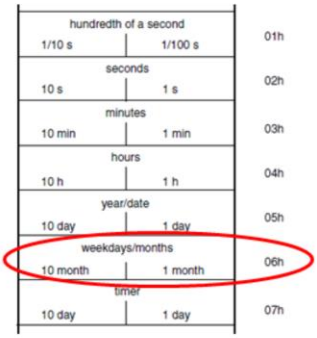
Počítanie rokov modulo 4.
0, 1, 2, 3, 0, 1, ...
Teda niekde v RAM –ke si pamätáme rok.
Napr.:
1999 = 1996 + 3
2000 = 2000 + 0
2021 = 2020 + 1



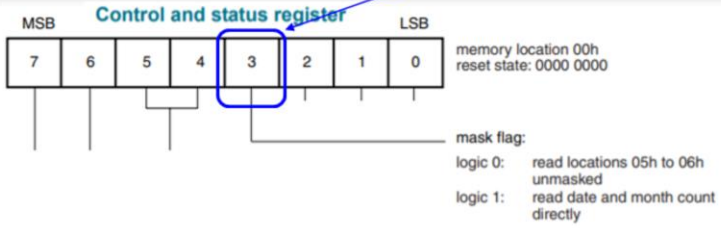
PCF 8583

Format of the weekdays and month counter





Control and status register



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PCF 8583

Cycle length of the time counters, clock modes

Unit	Counting cycle	Carry to next unit	Contents of month calendar
hundredths of a second	00 to 99	99 to 00	-
seconds	00 to 59	59 to 00	-
minutes	00 to 59	59 to 00	-
hours (24)	00 to 23	23 to 00	-
hours (12)	12 am	-	-
	01 am to 11 am	-	-
	12 pm	-	-
	01 pm to 11 pm	11 pm to 12 am	-
date	01 to 31	31 to 01	1, 3, 5, 7, 8, 10, and 12
	01 to 30	30 to 01	4, 6, 9, and 11
	01 to 29	29 to 01	2, year = 0
	01 to 28	28 to 01	2, year = 1, 2, and 3
months	01 to 12	12 to 01	-
year	0 to 3	-	-
weekdays	0 to 6	6 to 0	-
timer	00 to 99	no carry	-

23:59 59 99

00 01 02 . . . 11 12 13 . . . 23 24

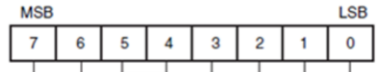
00 01

12 01 02 . . . 11 12 01 . . . 11 12

12 01

PCF 8583

Alarm control registers, clock mode



memory location 08h
reset state: 0000 0000

timer function:

000	no timer
001	hundredths of a second
010	seconds
011	minutes
100	hours
101	days
110	not used
111	test mode, all counters in parallel (factory use only)

timer interrupt enable:

0	timer flag, no interrupt
1	timer flag, interrupt

clock alarm function:

00	no clock alarm
01	daily alarm
10	weekday alarm
11	dated alarm

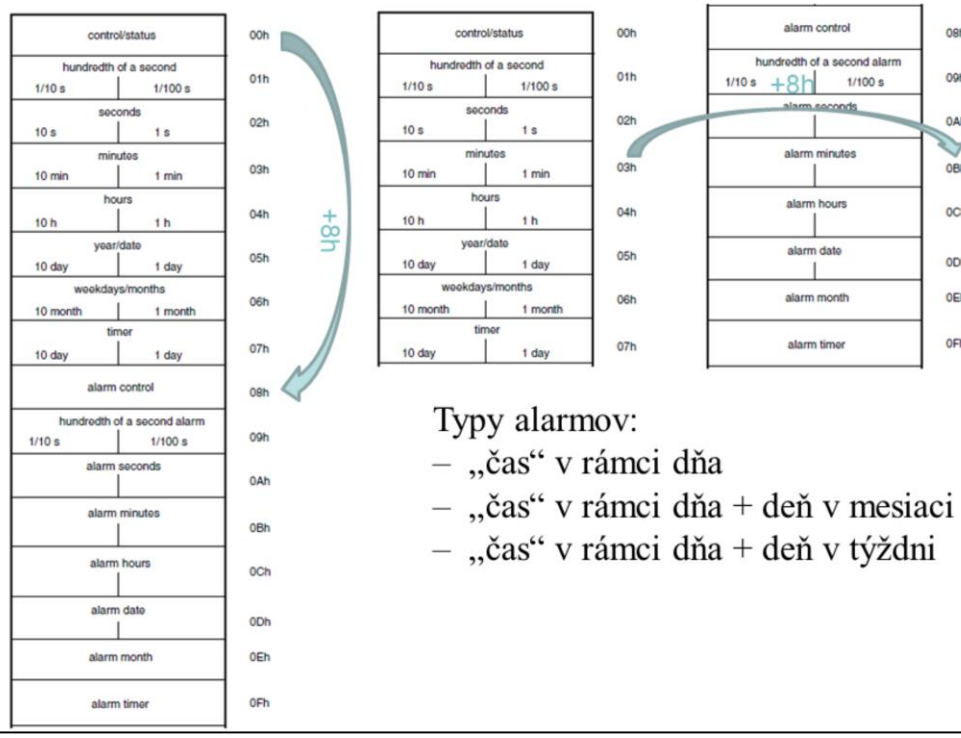
timer alarm enable:

0	no timer alarm
1	timer alarm

alarm interrupt enable:
(only valid when alarm enable in the control and status register is set)

0	alarm flag, no interrupt
1	alarm flag, interrupt

PCF 8583



Typy alarmov:

- „čas“ v rámci dňa
- „čas“ v rámci dňa + deň v mesiaci
- „čas“ v rámci dňa + deň v týždni

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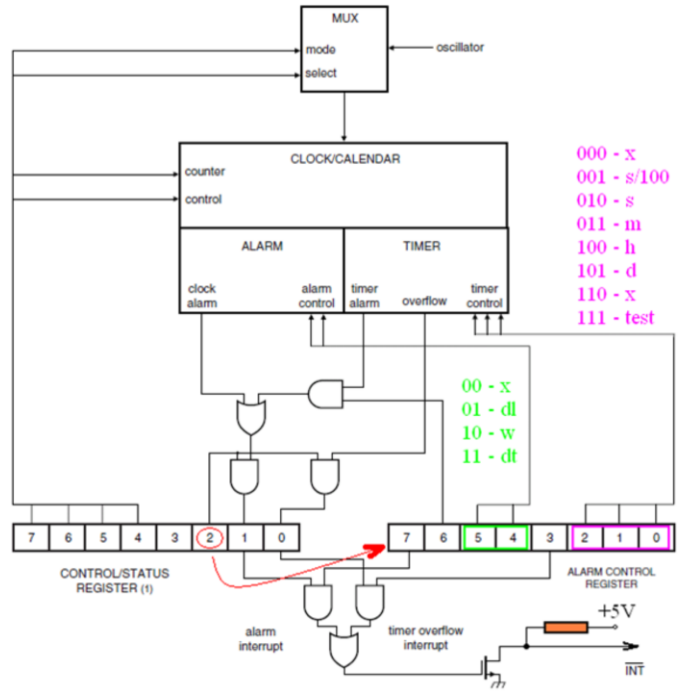
PCF 8583

CSR.2 = Alarm Enable bit



(1) If the alarm enable bit of the control and status register is reset (logic 0), a 1 Hz signal is observed on the interrupt pin $\overline{INT}$.

Alarm and timer interrupt logic diagram

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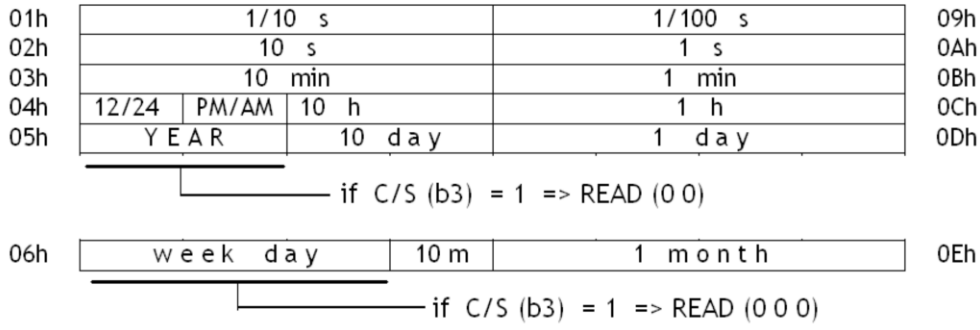
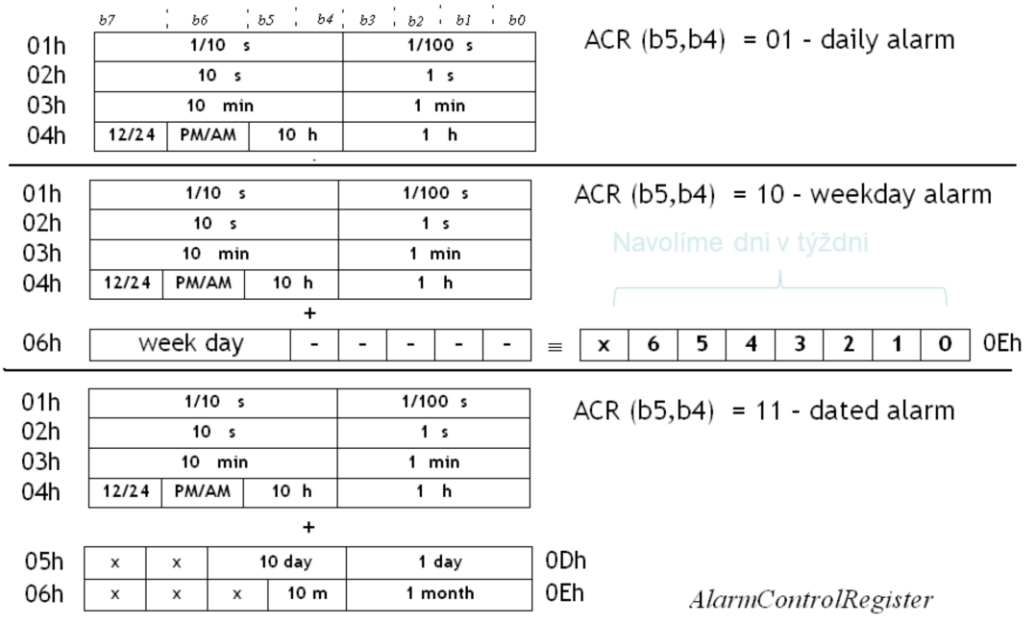
PCF 8583

Alarmy



PCF 8583


b7 b6 b5 b4 b3 b2 b1 b0
01h 1/10 s 1/100 s
02h 10 s 1 s
03h 10 min 1 min
04h 12/24 PM/AM 10 h 1 h
ACR (b5,b4) = 01 - daily alarm
01h 1/10 s 1/100 s
02h 10 s 1 s
03h 10 min 1 min
04h 12/24 PM/AM 10 h 1 h
ACR (b5,b4) = 10 - weekday alarm
Navolíme dni v týždni
+
06h week day - - - - - ≡ x 6 5 4 3 2 1 0 0Eh
01h 1/10 s 1/100 s
02h 10 s 1 s
03h 10 min 1 min
04h 12/24 PM/AM 10 h 1 h
ACR (b5,b4) = 11 - dated alarm
+
05h x x 10 day 1 day 0Dh
06h x x x 10 m 1 month 0Eh
AlarmControlRegister

PCF8563

Vlastnosti:

- CMOS RTC (roky (príznak storočí), mesiac, deň, deň v týždni, hodiny, minúty, sekundy); 16 8b-ových registrov (nie všetky bity sú implementované)
- I2C; až do 400 kb/s; slave (0x51) adresa pre: RD A3h
  WR A2h
- má zabudovaný obvod detekcie poklesu napájania
- zabudovaný AC sa inkrementuje automaticky po každom RD resp. WR.
-pri RD, resp. WR obsah počítadiel sa „odpamätá“. To znamená, že pri prenose cez rády sa negeneruje chyba.
- zabudovaný 32768Hz osc.
-obsah počítadiel je ukladaný v BCD formáte

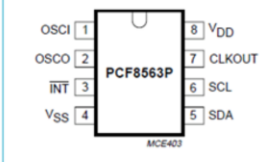
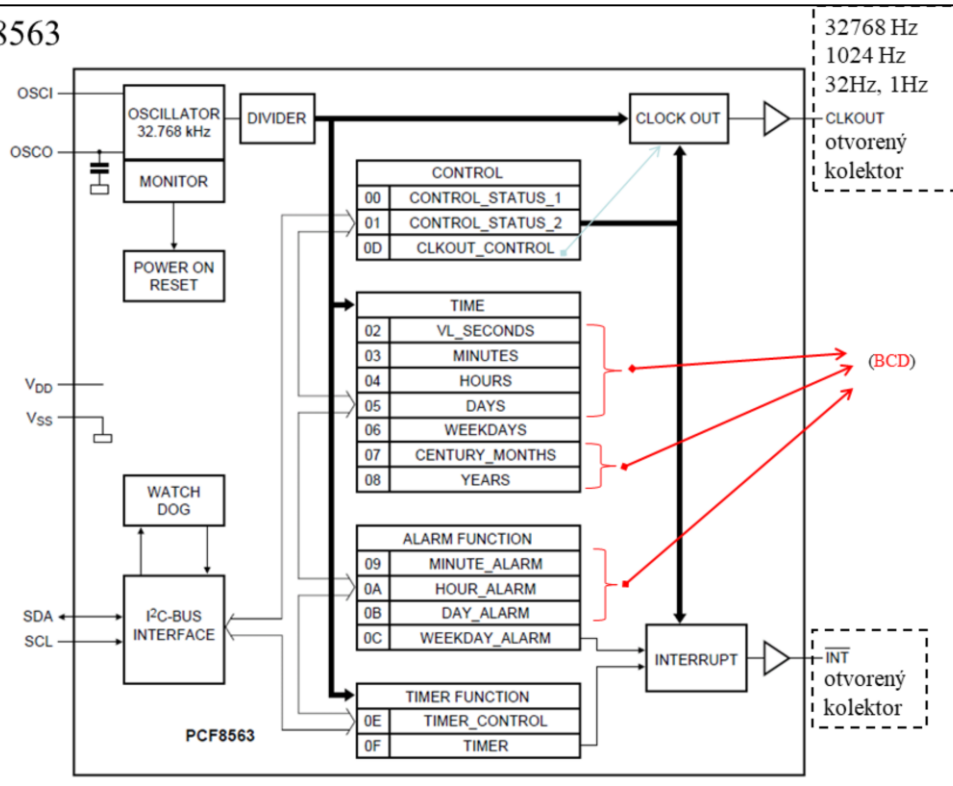


Fig 2. Pin configuration DIP8.

Symbol	Pin	Description
OSCI	1	oscillator input
OSCO	2	oscillator output
$\overline{INT}$	3	interrupt output (open-drain; active LOW)
V_{SS}	4	ground
SDA	5	serial data input and output
SCL	6	serial clock input
CLKOUT	7	clock output, open-drain
V_{DD}	8	positive supply voltage

PCF8563


32768 Hz
1024 Hz
32Hz, 1Hz
CLKOUT
otvorený
kolektor
OSCI
OSCO
OSCILLATOR
32.768 kHz
DIVIDER
CLOCK OUT
MONITOR
POWER ON
RESET
CONTROL
00 CONTROL_STATUS_1
01 CONTROL_STATUS_2
0D CLKOUT_CONTROL
TIME
02 VL_SECONDS
03 MINUTES
04 HOURS
05 DAYS
06 WEEKDAYS
07 CENTURY_MONTHS
08 YEARS
(BCD)
VDD
VSS
WATCH
DOG
ALARM FUNCTION
09 MINUTE_ALARM
0A HOUR_ALARM
0B DAY_ALARM
0C WEEKDAY_ALARM
SDA
SCL
I²C-BUS
INTERFACE
INTERRUPT
INT
otvorený
kolektor
TIMER FUNCTION
0E TIMER_CONTROL
0F TIMER
PCF8563

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PCF8563

Formatted registers overview

Bit positions labelled as x are not relevant. Bit positions labelled with N should always be written with logic 0; if read they could be either logic 0 or logic 1. After reset, all registers are set according to Table 27.

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
Control and status registers									
00h	Control_status_1	TEST1	N	STOP	N	TESTC	N	N	N
01h	Control_status_2	N	N	N	TI_TP	AF	TF	AIE	TIE
Time and date registers									
02h	VL_seconds	VL	SECONDS (0 to 59) (BCD)						
03h	Minutes	x	MINUTES (0 to 59) (BCD)						
04h	Hours	x	x	HOURS (0 to 23) (BCD)					
05h	Days	x	x	DAYS (1 to 31) (BCD)					
06h	Weekdays	x	x	x	x	x	WEEKDAYS (0 to 6)		
07h	Century_months	C	x	x	MONTHS (1 to 12) (BCD)				
08h	Years	YEARS (0 to 99) (BCD)							
Alarm registers									
09h	Minute_alarm	AE_M	MINUTE_ALARM (0 to 59) (BCD)						
0Ah	Hour_alarm	AE_H	x	HOUR_ALARM (0 to 23) (BCD)					
0Bh	Day_alarm	AE_D	x	DAY_ALARM (1 to 31) (BCD)					
0Ch	Weekday_alarm	AE_W	x	x	x	x	WEEKDAY_ALARM (0 to 6)		
CLKOUT control register									
0Dh	CLKOUT_control	FE	x	x	x	x	x	FD[1:0]	
Timer registers									
0Eh	Timer_control	TE	x	x	x	x	x	TD[1:0]	
0Fh	Timer	TIMER[7:0]							

Control registers

Control_status_1 - control and status register 1 (address 00h) bit description

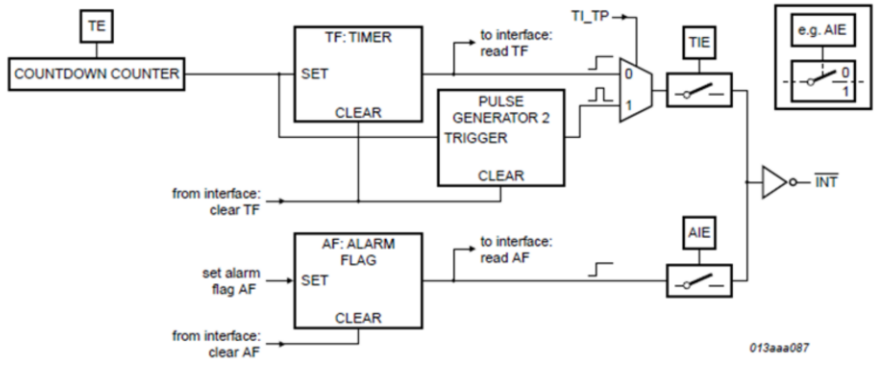
Bit	Symbol	Value	Description
7	TEST1	0	normal mode must be set to logic 0 during normal operations
		1	EXT_CLK test mode
6	N	0	unused
5	STOP	0	RTC source clock runs
		1	all RTC divider chain flip-flops are asynchronously set to logic 0; the RTC clock is stopped (CLKOUT at 32.768 kHz is still available)
4	N	0	unused
3	TESTC	0	Power-On Reset (POR) override facility is disabled; set to logic 0 for normal operation
		1	Power-On Reset (POR) override may be enabled
2 to 0	N	000	unused

Control_status_2 - control and status register 2 (address 01h) bit description

Bit	Symbol	Value	Description
7 to 5	N	000[1]	unused
4	TI_TP	0[2]	$\overline{INT}$ is active when TF is active (subject to the status of TIE)
		1	$\overline{INT}$ pulses active according to Table 7 (subject to the status of TIE); **Remark:** note that if AF and AIE are active then $\overline{INT}$ will be permanently active
3	AF	0[2]	read: alarm flag inactive
			write: alarm flag is cleared
		1	read: alarm flag active
			write: alarm flag remains unchanged
2	TF	0[2]	read: timer flag inactive
			write: timer flag is cleared
		1	read: timer flag active
			write: timer flag remains unchanged
1	AIE	0[2]	alarm interrupt disabled
		1	alarm interrupt enabled
0	TIE	0[2]	timer interrupt disabled
		1	timer interrupt enabled

[1] Bits labeled as N should always be written with logic 0.

[2] Default value.



When bits TIE and AIE are disabled, pin $\overline{INT}$ will remain high-impedance.

Fig 6. Interrupt scheme

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VL_seconds - seconds and clock integrity status register (address 02h) bit description

Bit	Symbol	Value	Place value	Description
7	VL	0	-	clock integrity is guaranteed OK
		1 Start-up value.		integrity of the clock information is not guaranteed /OK
6 to 4	SECONDS	0 to 5	ten's place	actual seconds coded in BCD format, see Table 9
3 to 0		0 to 9	unit place	

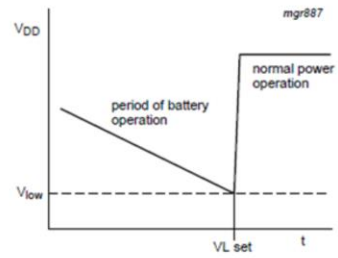

Fig 7. Voltage-low detection

PCF8563

VL_seconds - seconds and clock integrity status register (address 02h) bit description

Bit	Symbol	Value	Place value	Description
7	VL	0	-	clock integrity is guaranteed
		1 Start-up value.		integrity of the clock information is not guaranteed
6 to 4	SECONDS	0 to 5	ten's place	actual seconds coded in BCD format, see Table 9
3 to 0		0 to 9	unit place	

OK

/OK

Minutes - minutes register (address 03h) bit description

Bit	Symbol	Value	Place value	Description
7	-	-	-	unused
6 to 4	MINUTES	0 to 5	ten's place	actual minutes coded in BCD format
3 to 0		0 to 9	unit place	

Hours - hours register (address 04h) bit description

Bit	Symbol	Value	Place value	Description
7 to 6	-	-	-	unused
5 to 4	HOURS	0 to 2	ten's place	actual hours coded in BCD format
3 to 0		0 to 9	unit place	

Days - days register (address 05h) bit description

Bit	Symbol	Value	Place value	Description
7 to 6	-	-	-	unused
5 to 4	DAYS[1]	0 to 3	ten's place	actual day coded in BCD format
3 to 0		0 to 9	unit place	

[1] The PCF8563 compensates for leap years by adding a 29th day to February if the year counter contains a value which is exactly divisible by 4, including the year 00.

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Weekdays - weekdays register (address 06h) bit description

Bit	Symbol	Value	Description
7 to 3	-	-	unused
2 to 0	WEEKDAYS	0 to 6	actual weekday values, see

Weekday assignments

Day	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sunday	x	x	x	x	x	0	0	0
Monday	x	x	x	x	x	0	0	1
Tuesday	x	x	x	x	x	0	1	0
Wednesday	x	x	x	x	x	0	1	1
Thursday	x	x	x	x	x	1	0	0
Friday	x	x	x	x	x	1	0	1
Saturday	x	x	x	x	x	1	1	0

PCF8563 ver. 2004

Months/century (address 07H) bits description

Bit	Symbol	Value	Description
7	century[1]		this bit is toggled when the years register overflows from 99 to 00
		0	indicates the century is 20xx
		1	indicates the century is 19xx
4 to 0	month	01 to 12	this register holds the current month coded in BCD format, see Table 16

Month assignments

Month	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
January	C	x	x	0	0	0	0	1	1
February	C	x	x	0	0	0	1	0	2
March	C	x	x	0	0	0	1	1	3
April	C	x	x	0	0	1	0	0	4
May	C	x	x	0	0	1	0	1	5
June	C	x	x	0	0	1	1	0	6
July	C	x	x	0	0	1	1	1	7
August	C	x	x	0	1	0	0	0	8
September	C	x	x	0	1	0	0	1	9
October	C	x	x	1	0	0	0	0	10
November	C	x	x	1	0	0	0	1	11
December	C	x	x	1	0	0	1	0	12

Years (address 08H) bits description

Bit	Symbol	Value	Description
7 to 0	years	00 to 99	this register holds the current year coded in BCD format

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PCF8563 ver. 2012

Century_months - century flag and months register (address 07h) bit description

Bit	Symbol	Value	Place value	Description
7	C[1]	0[2]	-	indicates the century is x
		1	-	indicates the century is x + 1
6 to 5	-	-	-	unused
4	MONTHS	0 to 1	ten's place	actual month coded in BCD format, see
3 to 0		0 to 9	unit place	

[1] This bit may be re-assigned by the user.

[2] This bit is toggled when the register Years overflows from 99 to 00.

Month assignments in BCD format

Month	Upper-digit (ten's place)	Digit (unit place)				
	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
January	0	0	0	0	1	1
February	0	0	0	1	0	2
March	0	0	0	1	1	3
April	0	0	1	0	0	4
May	0	0	1	0	1	5
June	0	0	1	1	0	6
July	0	0	1	1	1	7
August	0	1	0	0	0	8
September	0	1	0	0	1	9
October	1	0	0	0	0	10
November	1	0	0	0	1	11
December	1	0	0	1	0	12

Years - years register (08h) bit description

Bit	Symbol	Value	Place value	Description
7 to 4	YEARS	0 to 9	ten's place	actual year coded in BCD format[1]
3 to 0		0 to 9	unit place	

[1] When the register Years overflows from 99 to 00, the century bit C in the register Century_months is toggled.

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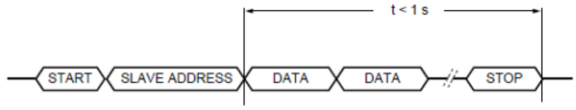
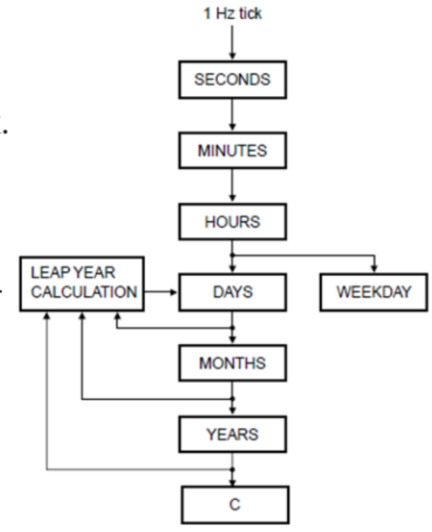
PCF8563

Počas RD, WR je inkrement na 1 sek. pozastavený.





Recommended method for reading the time:

1. Send a START condition and the slave address for write (A2h).
2. Set the address pointer to 2 (VL_seconds) by sending 02h.
3. Send a RESTART condition or STOP followed by START.
4. Send the slave address for read (A3h).
5. Read VL_seconds.
6. Read Minutes.
7. Read Hours.
8. Read Days.
9. Read Weekdays.
10. Read Century_months.
11. Read Years.
12. Send a STOP condition.

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PCF8563 Alarmové registre

Minute_alarm - minute alarm register (address 09h) bit description

Bit	Symbol	Value	Place value	Description
7	AE_M	0	-	minute alarm is enabled
		1[1]	-	minute alarm is disabled
6 to 4	MINUTE_ALARM	0 to 5	ten's place	minute alarm information coded in BCD format
3 to 0		0 to 9	unit place	

[1] Default value.

Hour_alarm - hour alarm register (address 0Ah) bit description

Bit	Symbol	Value	Place value	Description
7	AE_H	0	-	hour alarm is enabled
		1[1]	-	hour alarm is disabled
6	-	-	-	unused
5 to 4	HOUR_ALARM	0 to 2	ten's place	hour alarm information coded in BCD format
3 to 0		0 to 9	unit place	

[1] Default value.

Day_alarm - day alarm register (address 0Bh) bit description

Bit	Symbol	Value	Place value	Description
7	AE_D	0	-	day alarm is enabled
		1[1]	-	day alarm is disabled
6	-	-	-	unused
5 to 4	DAY_ALARM	0 to 3	ten's place	day alarm information coded in BCD format
3 to 0		0 to 9	unit place	

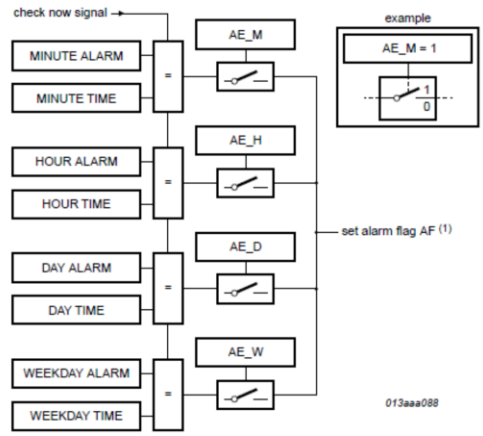
[1] Default value.

PCF8563 Alarmové registre

Weekday_alarm - weekday alarm register (address 0Ch) bit description

Bit	Symbol	Value	Description
7	AE_W	0	weekday alarm is enabled
		1[1]	weekday alarm is disabled
6 to 3	-	-	unused
2 to 0	WEEKDAY_ALARM	0 to 6	weekday alarm information

[1] Default value.



(1) Only when all enabled alarm settings are matching.
It's only on increment to a matched case that the alarm flag is set, see Section 8.6.5.

Fig 10. Alarm function block diagram

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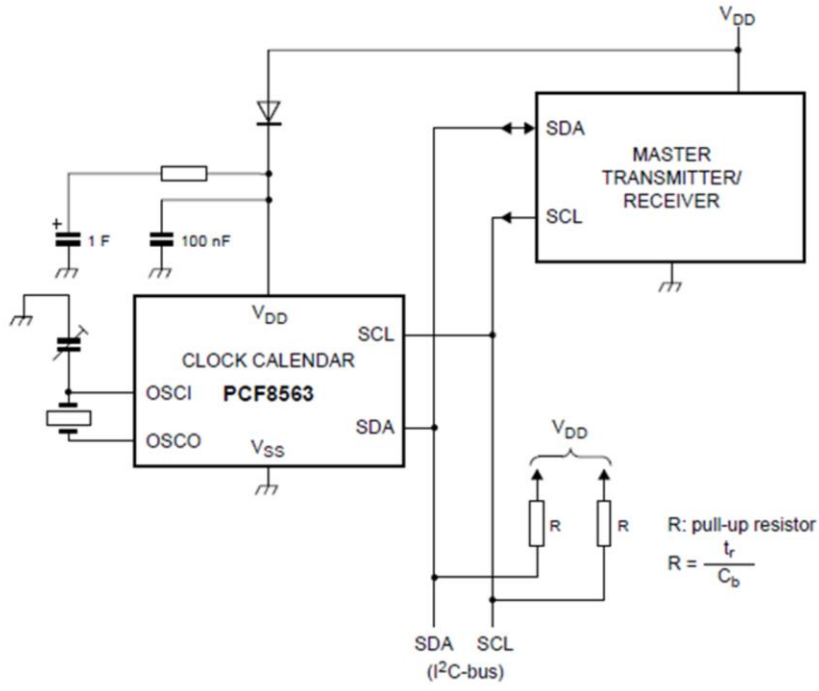
Pripojenie na I2C zbernicu.



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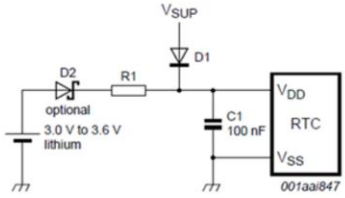
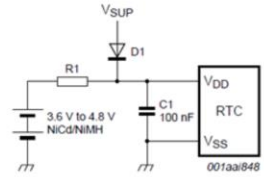
Napájanie:



D2 may not always be necessary. Refer to text.

Backup circuit using primary lithium cell



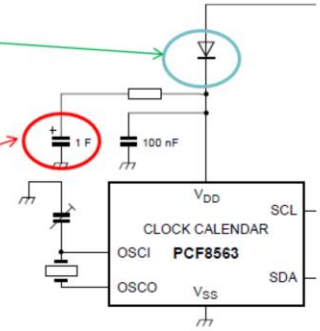
Due to the low RTC current consumption, a parallel diode over R_1 (directed from the battery to the RTC) will not be of any use.

The voltage drop over R_1 is small

Backup circuit using secondary cell (NiCd or NiMH)

Some suggestions for diode D1

	1N4148	BAS45A	BAS45AL	BAS716	BAS116	BAV170
Package	leaded	leaded	SMD	SMD	SMD	SMD
Typ. reverse current I_R at 25 °C	-	0.2 nA	0.2 nA	0.2 nA	3 pA	3 pA
Max. reverse current I_R at 25 °C	25 nA	1 nA	1 nA	5 nA	5 nA	5 nA
Price indication, relative w.r.t. 1N4148	1 (0.02 $)	7x	8x	3.5x	3x	3x



Overview of common backup supply components and key selection criteria

Technology	Operating Temperature [° C]	Self-discharge rate	Charging circuit and nr. of cycles	Backup time	Cost	Restrictions on disposal and safety
Primary Lithium	-30 to +80	Low	n.a.	Long	Low	High
Rechargeable (NiCd / NiMH)	0 to +40 (during charging)	Medium	Simple / ± 500	Short	Medium	Medium
Super Capacitor	-40 to +85	High	Simple / unlimited	Short	Medium / High	Low

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“ppm”

“The second (abbreviation, s or sec) is the Standard International (SI) unit of time.
One second is the time that elapses during 9,192,631,770 ($9.192631770 \times 10^{9}$) cycles of the radiation produced by the transition between two levels of the cesium 133 atom.”

To odpovedá chybe 1s za niekoľko milion rokov. Čo je cca 10^{-8} ppm.
Čo je to 1ppm?

Čo to znemená, ak povieme hodiny utekajú/meškajú 1s/deň?
1s/ (počet sekund za deň) = 1/(24*3600)= 11,57ppm

1 s/year = 0.031 ppm.

Percento: koľká časť zo sto.

ppm: koľká časť z milióna.